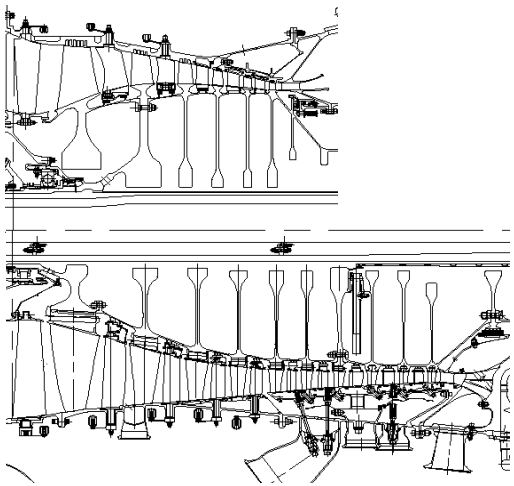
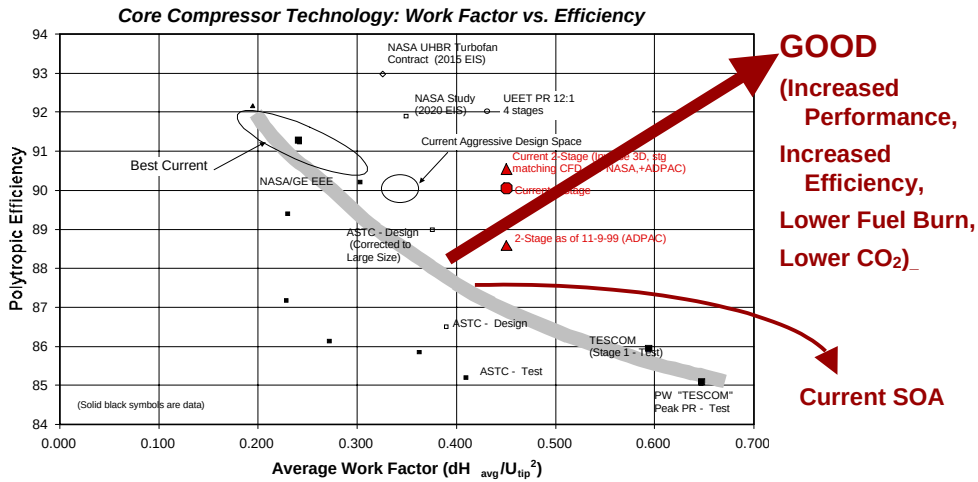
Ultra Efficient Engine Technology Program

Milestone Accomplishment

Example UEET Goal State

State of the Art (SOA)





Accomplishment: UEET Level I Milestone, 'Candidate concept for ultra-high aerodynamic loading identified and selected through CFD simulation', has been accomplished. The milestone is to select the most promising compressor flow control concepts to meet the UEET program goals. It was met by selecting an inverse design technique for optimum blade shape and shock placement, and by managing the flow between the blade tips and endwall (inner compressor liner) with the proper matching of highly loaded stages. Application of these techniques is reducing overall losses and enabling higher efficiency at higher aerodynamic loading on the compressor blades.

Significance: By using an inverse design technique and managing flow between the compressor blade tips and endwall, these techniques could lead to compressor designs with fewer stages and a system that is lighter-weight, thus attaining revolutionary gains in compressor performance. It is expected that these design methodologies will result in attaining the UEET goals of reducing CO2 emissions and increasing efficiency of advanced aircraft engines.

Ultra Efficient Engine Technology Program

Milestone Accomplishment

Highly-Loaded Turbomachinery

Point of Contact: K. Civinskas, GRC (714-03)
Technical Lead: M. Hathaway
June 2000

Relevant Milestone (Core Compressor portion of Level 1 Milestone): *Candidate concept for ultra-high aerodynamic loading identified and selected through CFD simulation (Jun 00)*

Accomplishment / Relation to Milestone and ETO:

- *Removal of 2D boundary layer thru suction surface bleed (aspiration) computationally shown to provide up to 25% greater diffusion*
- *Aspiration applied in 3D environment of first two stages of UEET compressor did not significantly improve efficiency of front stages (Aspiration being considered for the rear stages of UEET 4-stage design)*
- *Inverse design technique (for better shock management & stage matching) & blade tip/endwall flow management (recirculating casing treatment) identified as most promising concepts for achieving UEET compressor goals*

Application of inverse design techniques and management of blade tip/endwall flows is reducing overall losses and enabling higher efficiency at higher aerodynamic loadings. Resultant improvements in efficiency, fuel burn, and stage count contribute to the Enterprise EMISSIONS (CO_2) and COST REDUCTION Goals

Highly-Loaded Turbomachinery

Point of Contact: K. Civinskas, GRC (714-03)
Technical Lead: M. Hathaway
June 2000

Relevant Level I Milestone: *Candidate concept for ultra-high aerodynamic loading identified through CFD simulation (Jun 00)*

Shown: Compressor State-of-the-Art w/Accomplishment & Exit Criteria

Future Plans:

- *Reduce tip speed & continue assessment of aspiration in rear stages of UEET 4-stage design.*
- *Proceed with 2-stage POC mechanical assessment*
- *Ultra-high-loaded core compressor design with & without aspirated blading underway*
- *Assess additional flow control concepts that could impact the UEET 4-stage*
- *New recirculating casing treatment to be tested on stage 67 at GRC in mid FY01.*

Ultra Efficient Engine Technology Program

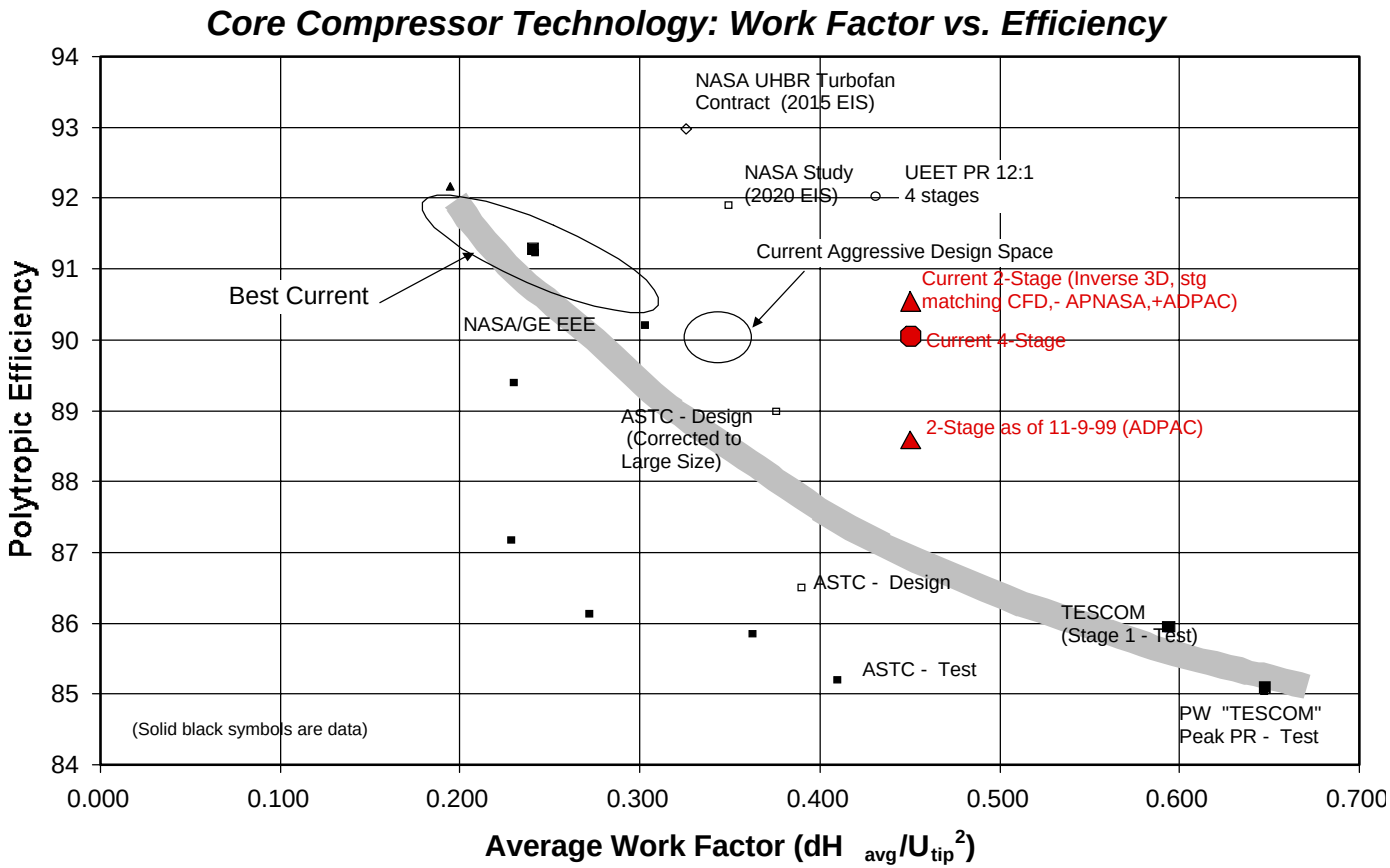
Milestone Accomplishment

Milestone Goal Met:

Candidate flow control concepts identified that allows 25% greater suction surface diffusion with <1% mass flow

Minimum success:

Allows 15% greater suction surface diffusion with <1% mass flow



- *CFD simulations defining 2-stage proof-of-concept (POC) vehicle for the UEET core compressor show 25% greater diffusion factors*
- *CFD simulations of recirculating casing treatment (yet to be applied to the UEET designs) indicate an increase stable operating range up to 80% for clean non-distorted inflow with no loss in efficiency*